Report for 2002MO3B: Development of Wax-Rich Grout for Borehole Sealing

There are no reported publications resulting from this project.

Report Follows:

Summary Report: Development of a wax/glass grout for sealing boreholes

T. M. Whitworth
Associate Professor
Dept. of Geological and Petroleum Engineering
University of Missouri-Rolla

Steve Knobbe
Design Engineer
Geoprobe Systems
Salina, KS 67401

Paraffin wax and silt-sized glass have a number of physical properties that make them well suited for use as a heated, injectable mixture. Paraffin wax has a very small polymer chain size, a low viscosity, and is waterproof and inexpensive. Glass provides strength and increases the density of the mixture. This combination can seal rock and soil in the subsurface both above and below the water table, significantly decreasing the hydraulic conductivity.

Our experiments demonstrated that melted paraffin wax and silt-sized glass mixtures cannot penetrate into all types of subsurface material. Hydrated clays and silt are not effectively penetrated by the wax-based grout mixtures because of the small grain size. Pressure injection of the hot, liquid grout may result in a deformation of the hydrated clay or silt as the wax is forced out of the perforated tube, resulting in some forced penetration into the clay or silt. In addition, if there are interconnected spaces within the clay or silt, the grout mixtures can flow through and seal these voids.

Unconsolidated materials such as sands have a much larger grain size than the clays, which allows the wax to flow around and seal the grains. As a general rule, our experiments show that a wax-based grout does not seal any material with a grain size smaller than sand. The wax grout mixtures are also well suited for sealing interconnected fractures in both hard rock, such as dolomite, and soft rock, such as shale.

These experiments were conducted where samples were exposed to wet and dry conditions, simulating areas at and above the water table, respectively. Success was highly variable since some injections were able to seal all of the samples in a wet trial while not successfully sealing others in the accompanying dry trial. The opposite was also found to be true. A sample would typically fail due to inadequate grout volume.

Evaluation of the physical parameters of the paraffin wax and silt-sized glass show that grout mixtures can be created that are both lighter and heavier than water, thus controlling the buoyancy of the mixture in water. Testing shows that shear strength of the grout increases with an increase in the volume of clay-sized glass in the mixture.

The wax-glass mixture is not without its problems. The mixture is not always successful at sealing all of the void spaces within the soil or rock, and organic chemicals and microbes may degrade the mixture over time. However, it may be useful for sealing rock fractures and permeable sands.

A follow-up proposal (total budget $400,000) has been submitted to NIOSH and proposes to test the ability of wax grout mixtures to seal fractures in mines and prevent water influx. A paper describing the results of this research is also in preparation and will be submitted to a peer-reviewed journal before the end of the summer.